Retardation of Poultry Spoilage by Processing with Chlortetracycline

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When poultry were dipped for 2 hours in a solution containing 1 to 20 p.p.m. of chlortetracycline, bacteriostatic amounts of antibiotic could be demonstrated in the meat; however, such amounts of antibiotic were not obtained by feeding chlortetracycline in concentrations as high as 1000 p.p.m. to poultry before slaughter. Poultry processed under commercial conditions, with this antibiotic present at 10 to 15 p.p.m. in the chill tanks, keep fresh and edible significantly longer than control birds. The keeping quality of poultry on the verge of spoiling was not improved by dipping in chlortetracycline solutions.

THE YEARLY ECONOMIC LOSS due to the spoilage of poultry meat in this country is estimated at more than $132,000,000 (*3*). With the growing trend by retailers toward cut-up tray-packed poultry, which necessitates further handling of the poultry before it reaches the consumer, the development of "sliming" and off-odors has become increasingly apparent.

Bacteriological studies have shown (*1*) that as poultry spoils there is a tremendous increase concomitantly in the bacterial population on the surface of the poultry. The possible use of antibiotics to retard the growth of spoilage bacteria was investigated. An antibiotic to be considered for such application should be effective in minute quantities in preventing growth of microorganisms, and should be a safe food additive.

Kohler, Miller, and Broquist (*5*) found that when poultry spoilage microorganisms were cultured on nutrient agar plates containing various test antibiotics, Aureomycin chlortetracycline was the only antibiotic of ten tested that effectively suppressed growth of the microorganisms. (The trademark of the American Cyanamid Co. for the antibiotic chlortetracycline is Aureomycin. Experiments with chlortetracycline described in this paper were carried out with chlortetracycline hydrochloride.)

In experiments in the authors' laboratories (*6*), 335 bacterial cultures were picked from isolated clones of poultry spoilage microorganisms on nutrient agar plates and individually tested by conventional tube assay techniques; 99.4% of the cultures were effectively inhibited by 1 p.p.m. of chlortetracycline in the culture medium. These experiments gave additional meaning to earlier work in which freshly killed and dressed poultry were dipped in a solution containing a few parts per million of chlortetracycline in an attempt to obtain sufficient antibiotic on the surface of the poultry to retard the growth of spoilage bacteria. This procedure was found to be highly effective in keeping chicken fresh and edible for a significantly longer time than untreated controls (*5*).

Prolonged feeding of comparatively high levels of chlortetracycline to farm animals, or the prolonged administration of chlortetracycline to human subjects has not produced untoward effects (*4*). The amount of chlortetracycline absorbed by eviscerated chicken dipped in a 10-p.p.m. solution of chlortetracycline for 2 hours is about 1 mg. per 2 pounds of bird; hence, it would be necessary to eat 2000 pounds of raw chicken to consume enough chlortetracycline to equal a therapeutic dose of antibiotic. Furthermore, chlortetracycline is heat labile and in poultry meat is rapidly destroyed by conventional cooking procedures (*2*, *5*), even when poultry are dipped in chlortetracycline solutions 100 times greater than that required to give an adequate increase in shelf life.

Absorption of Chlortetracycline by Poultry Meat

The amount of chlortetracycline commonly employed in poultry rations ranges from 10 to 200 p.p.m. in the feed depending on the prevailing "disease level." The effect of feeding a high level of chlortetracycline to poultry on the keeping qualities of the meat was considered. Even when 1000 p.p.m. of chlortetracycline were fed, only 0.1 p.p.m. was detected in the flesh (Figure 1).

In sharp contrast with the results of earlier experiments (*2*), was the finding that when whole eviscerated poultry were dipped in cold water (3° C.) containing 1 p.p.m. of chlortetracycline for 2 hours, the breast muscle contained a greater amount of antibiotic than that from poultry fed 1000 p.p.m. of chlortetracycline (*5*). Poultry dipped in a solution containing 10 p.p.m. of chlortetracycline subsequently contained about 2 p.p.m. of antibiotic, which would be expected to exert a bacteriostatic effect (*7*). Thus, these data (Figure 1) showed that the antibiotic is readily absorbed into poultry dipped into water containing a few parts per million of chlortetracycline and bacteriostatic levels can be readily obtained by this procedure.

Poultry Preservation under Commercial Conditions

Table I describes in detail six experiments carried out in poultry processing plants in different areas of the country. The poultry were held in cold storage at the indicated location and periodically observed for spoilage characteristics. The processing steps may be summarized as: dressing-line operations, eviscerating-line operations, weighing and chilling, and segmenting and packaging-line operations.

The chilling step was carried out by immersing several hundred birds for 2 hours in a 200-gallon tank containing a mixture of cold water and crushed ice. Chlortetracycline was added to the chilling tank to a final concentration of about 10 p.p.m.

In trial 1, Table I, freshly killed, whole eviscerated chickens were held for 2 hours in chill tanks with and without chlortetracycline, then dry-packed and trucked to a poultry distributor where the poultry was held in cold storage. The birds were examined at weekly intervals for evidence of slime, odor, bloom, or other undesirable effects. The extent of bacterial spoilage was determined by washing off the bacteria on the surface of the chickens and plating these rinsings into nutrient agar using the pour plate technique (*5*). At the end of one week no difference could be detected organoleptically between the control group and the groups processed with chlortetracycline; however, the bacteriological findings showed that the control group of birds had a several hundredfold higher bacterial load. At the end of the second week the control group was clearly spoiling, in contrast to the chlortetracycline-processed groups. At the end of the third week the latter groups were still fresh and were distributed to 45 families to be cooked and eaten. No significant taste differences were noted when such poultry meat was compared with the freshly killed product. The additional trials in Table I illustrate the effectiveness of chlortetracycline in significantly extending the shelf life of poultry. The trials were carried out in plants equipped with inplant chlorination as well as some that were not. Processing with chlortetracycline was highly effective in both instances. The last trial of Table I is particularly interesting because after processing with chlortetracycline in plant E, the birds were packaged by three different methods, trucked under refrigeration several hundred miles in 100° F. heat to a retail store, and kept in the refrigerated display counter for 3 weeks without the appearance of odor or slime.

Inability to Make Spoiling Poultry Fresh

Poultry with a high initial bacterial count spoil faster than poultry with a low bacterial count. Ayres, Ogilvy, and Stewart (*1*) demonstrated that poultry stored at 40° C. with an initial bacterial load of 10^3 microorganisms per sq. cm. of surface kept twice as long as poultry with an initial bacterial load of 10^6 microorganisms per sq. cm. In many laboratory experiments, chlortetracycline, which is primarily bacteriostatic, was less effective in extending the shelf life of poultry with a high bacterial count than when freshly killed poultry were employed.

In the experiment outlined in Table II, portions of cut-up poultry which had a high initial bacterial load of 1.83×10^6 microorganisms per gram were dipped in the indicated solutions of chlortetracycline. Other portions of untreated poultry were held in cold storage for 4 and 6 days to obtain partially spoiled poultry meat for subsequent dipping with chlortetracycline solutions. Initial data with cut-up poultry (0 storage days at 3° C., Table II), made it necessary to dip the poultry in 300 p.p.m. of chlortetracycline in order to keep the bacterial load from increasing over a cold storage period of 7 days. When poultry were used that smelled badly and had a bacterial load of 514×10^6 microorganisms per gram, dipping in 30 p.p.m. of chlortetracycline had no beneficial effect. Processing such poultry with 300 p.p.m. of antibiotic subsequently reduced the bacterial load only about tenfold with no organoleptic improvement.

Spoilage Characteristics of Poultry Fed High Level of Chlortetracycline

An important source of bacterial contamination in poultry processing

Table I. Processing of Whole Eviscerated Poultry under Commercial Conditions with Chlortetracycline to Retard Bacterial Spoilage

Poultry Plant and Location	Implant Chlorination	No. of Poultry Processed per Group	Chlorotetracycline in Cooling Tank, P.P.M.	Type of Packing	Cold Storage Facilities,[a] 3° C.	Condition of Poultry Following Cold Storage after: 1 Week (Microorganisms $\times 10^6$/G. and Organoleptic State)		2 Weeks		3 Weeks	
Plant A, trial 1, Pennsylvania	Yes	100	None	Dry pack	NYC, A	0.52	No odor or slime	605	Strong odor	3700	Strong odor, slime
		100	10	Dry pack	NYC, A	0.003	No odor or slime	1.1	No odor or slime	16	No odor or slime
		100	10[b]	Dry pack	NYC, A	0.001	No odor or slime	0.01	No odor or slime	0.77	No odor or slime
Plant A, trial 2, Pennsylvania	Yes	10	None	Cut up, tray pack	ACL	355	Slight odor	2045	Putrid	3220	Putrid
		16	15[b]	Cut up, tray pack	ACL	0.006	No odor or slime	5	Very slight odor	112	Slight odor
Plant B, Maryland	No	14	None	Dry pack	NYC, B			Odors, unsalable			
		14	10	Dry pack	NYC, B			No odor, full bloom			
Plant C, Ohio	Yes	32	None	Cut up, tray pack	ACL	0.243	No odor or slime	1055	Putrid	1110	Putrid
		32	13[b]	Cut up, tray pack	ACL	0.004	No odor or slime	3.5	No odor or slime	4.4	Slight odor
Plant D, Massachusetts	No	50	None	Dry pack	ACL	0.097	Very slight odor	42.5	Very strong odor	580	Putrid
		50	13[b]	Dry pack	ACL	0.001	No odor or slime	0.87	Slight odor	9.7	Slight odor
Plant E, Arkansas	No	48	10	Ice pack	TKR					0.97	No odor or slime
		48	10	Dry pack	TKR					0.43	No odor or slime
		48	10	Ice and tray pack	TKR					19.5	No odor or slime

[a] NYC, A = New York City wholesaler A; ACL = American Cyanamid Laboratories, Pearl River, N. Y.; NYC, B = New York City wholesaler B; TKR = Topeka, Kan., retailer.
[b] Chlortetracycline added as Acronize PD, trademark of formulated product containing salt, citric acid, and 10% chlortetracycline.

Table II. Lack of Effectiveness of Chlortetracycline (CTC) in Extending Shelf Life of Spoiling Poultry

Storage, Days: Before CTC dip, 3° C.	Storage, Days: After CTC dip, 3° C.	Microorganisms × 10^6/G., Concn. of CTC Dip, P.P.M.: 0		3		30		300	
0	0	1.83	Good	1.83	Good	1.83	Good	1.83	Good
	7	2610	Strong odor	83	Slight odor	21.2	Slight odor	0.83	Slight odor
	14	810	Strong odor	129	Slight odor	69	Slight odor	9.1	Slight odor
4	0	514	Strong odor	514	Strong odor	514	Strong odor	514	Strong odor
	7	219	Strong odor	425	Strong odor	400	Strong odor	49	Slight odor
	14	700	Putrid	945	Strong odor	405	Strong odor	77.5	Strong odor
6	0	620	Putrid	620	Putrid	620	Putrid	620	Putrid
	7	390	Putrid	400	Putrid	29.5	Strong odor	25.5	Strong odor
	14	296	Putrid	1520	Putrid	300	Strong odor	210	Strong odor

plants arises from the great numbers of bacteria present in the intestinal tract of the poultry. Although bacteriostatic amounts of chlortetracycline could not be demonstrated in the flesh of poultry fed a high level of chlortetracycline (Figure 1), it was of interest to determine if such poultry might be less susceptible to spoilage, as their intestinal microflora might be altered in content of spoilage organisms.

In the experiment summarized in Table III, birds were obtained that had been fed 100 p.p.m. of chlortetracycline for their entire life. These birds were dressed and divided into two groups, one of which was dipped in 10 p.p.m. of chlortetracycline for 30 minutes. Poultry which had never been fed an antibiotic-containing ration were similarly treated. All of the poultry were then held in cold storage and examined after 1 and 2 weeks. The poultry which had been fed the antibiotic-containing ration, but were not processed with chlortetracycline after slaughtering (group 3, Table III), spoiled just as rapidly as did the untreated poultry that had never been fed an antibiotic-containing ration (group 1).

The shelf life of the chlortetracycline-fed poultry (group 4) and the shelf life of poultry fed the regular ration (group 2) were extended by processing with chlortetracycline. When poultry are fed chlortetracycline for a long-time period, possibly strains of bacteria resistant to chlortetracycline do not develop to any significant degree; for if the predominant source of poultry spoilage organisms is of intestinal origin, the data of Table III demonstrate that the microflora of such birds are sensitive to chlortetracycline.

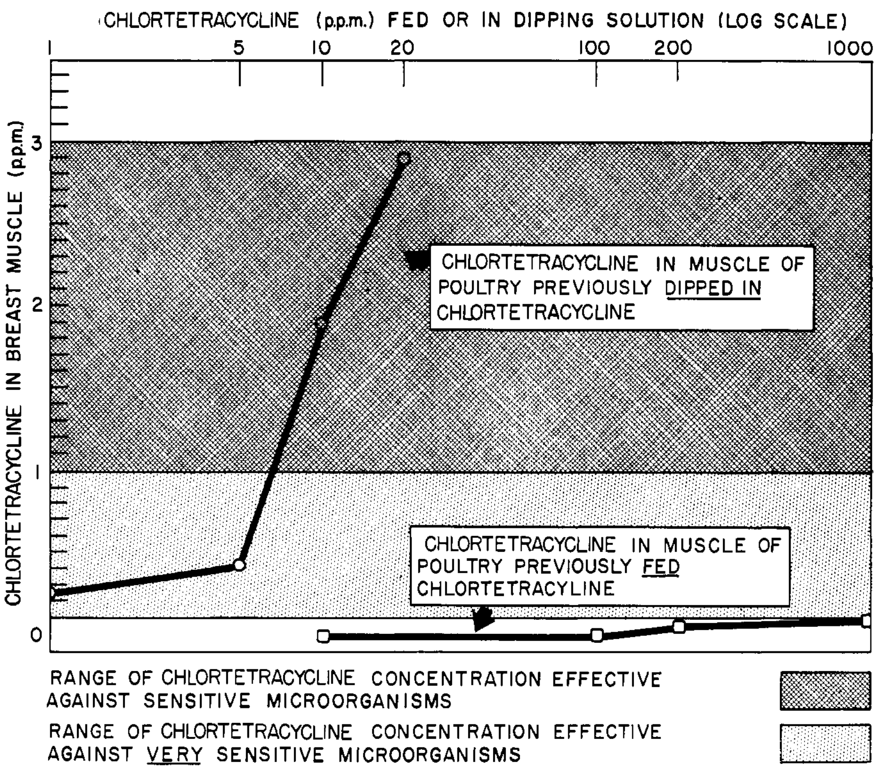

Figure 1. Chlortetracycline content of chicken breast muscle following feeding of chlortetracycline to poultry or dipping dressed poultry in chlortetracycline solution

Table III. Effectiveness of Chlortetracycline in Extending Shelf Life of Poultry Previously Fed Chlortetracycline

Group No.	Chlortetracycline in Feed, P.P.M.	Chlortetracycline in Dipping Water, P.P.M.	Days in Cold Storage	Microorganisms × 10^6/G.	Organoleptic Conditions
1	None	0	7	180	Very slight odor
2	None	10	7	0.2	Good, no odor
3	100	0	7	500	Very slight odor
4	100	10	7	0.16	Good, no odor
1	None	0	14	660	Putrid
2	None	10	14	300	Very slight odor
3	100	0	14	1070	Strong odor
4	100	10	14	118	Good, no odor

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